

Patent Claims

1. Apparatus for humidifying at least one gas stream, in particular a gas stream flowing to a fuel cell system, this gas stream flowing through a humidifier device through which, moreover, a humid gas stream, in particular a humid exhaust-gas stream from the fuel cell system, flows, and the two gas streams being separated from one another by one or more membrane(s) which is/are permeable to water vapor, characterized in that there is at least one bypass line (12, 13), through which at least one of the gas streams is partially routed in such a way that it does not come into contact with the membrane (8).
2. The apparatus as claimed in Claim 1, characterized in that part of the gas stream which is to be humidified is routed in the bypass line (13), this part of the gas stream that is to be humidified, downstream of the bypass line (13), being combined again with that part of the gas stream to be humidified that is flowing through the humidifier device (7).
3. The apparatus as claimed in Claim 1 or 2, characterized in that a part of the humid gas stream is routed in the bypass line (12).
4. The apparatus as claimed in Claim 1, 2 or 3, characterized in that the gas stream that is to be humidified is the feed air for a cathode space (5) of a fuel cell (2) of a fuel cell system (1).
5. The apparatus as claimed in one of Claims 1 to 4, characterized in that the humid gas stream contains at least a part of the exhaust gases from a fuel cell (2) of a fuel cell system (1).
6. The apparatus as claimed in one of Claims 1 to 5, characterized in that the at least one bypass line (12, 13) is integrated in the humidifier device (7) itself.

7. The apparatus as claimed in Claim 6, characterized in that the at least one bypass line (12, 13) is arranged in such a way in the humidifier device (7) that any condensate which collects flows out through the bypass line (12, 13).
8. The apparatus as claimed in Claim 6 or 7, characterized in that a device for varying the volumetric flow through the at least one bypass line (12, 13) is likewise integrated in the humidifier device (7).
9. The apparatus as claimed in Claim 8, characterized in that the device for varying the volumetric flow through the at least one bypass line (12, 13) is designed in the form of a valve plunger (17) which opens up a different cross section of the bypass line (12, 13) depending on the distance to an inlet or outlet opening of the bypass line (12, 13).
10. The apparatus as claimed in Claim 8, characterized in that the device for varying the volumetric flow through the at least one bypass line (12, 13) is designed in the form of a variable diaphragm which opens up a different cross section of the bypass line (12, 13) depending on the position and opening diameter.
11. The apparatus as claimed in Claim 8, characterized in that the device for varying the volumetric flow through the at least one bypass line (12, 13) is designed in the form of two discs (18) which can rotate relative to one another, are provided with openings (19) and open up a different cross section of the bypass line (12, 13) and/or of the region comprising the membrane (8) depending on their angle of rotation with respect to one another.
12. The apparatus as claimed in one of Claims 1 to 11, characterized in that the humid gas stream, after it has flowed through the humidifier device (7) and/or the bypass line (12), is routed into a further humidifier device (24), of similar structure, in order to humidify a further gas stream that is to be humidified.

13. The apparatus as claimed in Claim 12, characterized in that the further gas stream that is to be humidified is the feed air passing into a gas generation device (6) of the fuel cell system (1).
14. A method for humidifying a gas stream using the apparatus as claimed in one of Claims 1 to 13, characterized in that to set a predetermined dew point in the at least one gas stream that is to be humidified the quantity of gas that is to be humidified is routed through the at least one bypass line (12, 13) and/or the quantity of humid gas is varied accordingly.
15. The use of the apparatus as claimed in one of Claims 1 to 13 to dry a humid gas stream.
16. The use of the apparatus as claimed in one of Claims 1 to 13 to humidify and/or dry a gas stream in a fuel cell system, together with the method as described in Claim 14.
17. The use as claimed in Claim 16, in which the fuel cell system (1) is used as an electrical energy generator in a land, water or air vehicle.
18. The use as claimed in Claim 17, in which the electrical energy generator is used to provide driving energy.
19. The use as claimed in Claim 17 or 18, in which the electrical energy generator is used as an auxiliary power unit (APU).